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In Memoriam

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About The Cover

On January 28, 1986, at approximately 11:40 a.m. EST, the flight of Space Shuttle Mission 51-L abruptly ended in an explosion.

It is with great sadness that we mourn the passing of these men and women who were members of our NASA family, but it is more important to remember them for their bravery and zest for challenge.

In President Reagan's statement to the Nation, he said, "The crew of the Shuttle Challenger honored us by the manner in which they lived their lives. We will never forget them nor the last time we saw them—this morning—as they prepared for their journey and waved goodbye, and slipped the surly bonds of Earth to touch the face of God."

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Highlights of 1985 NASA Activities

An encounter with the Comet Giacobini-Zinner and nine Space Shuttle missions were among the highlights of the year 1985.

Continuing efforts to develop a permanently manned Space Station were capped in 1985 by awarding contracts to eight industry teams for definition and preliminary design.

NASA began the flight research program of the highly advanced X-29 aircraft in March and the first test flight of the mission adaptive wing was made in October.

Space Flight

The Office of Space Flight had its busiest year ever with nine Space Shuttle flights and three Atlas Centaur and two Scout launches and the last launch of the Aerobee vehicle from all four of the continental launch sites—the Eastern and Western Space and Missile Centers, Wallops Island and White Sands.

The Scout launches, from the Western Space and Missile Center (WSMC), Vandenberg Air Force Base, Calif., and Wallops Flight Facility, Wallops Island, Va., were for the Department of Defense—one for the Air Force and a dual satellite launch from WSMC for the Navy. The Aerobee was launched from White Sands for research purposes and closed the chapter on the use of the Aerobee as a sounding rocket.

The Atlas Centaur launches, all from the Eastern Space and Missile Center, Fla., put Intelsat VA satellites F10, F11 and F12 into synchronous orbit. These satellites will serve the International Telecommunications Satellite Consortia (Intelsat) for up to a decade.

The Space Transportation System's Space Shuttle, along with PAM-D and D-2 upper stages from McDonnell Douglas Corp. and integral upper stages from Hughes, placed 11 communications satellites into synchronous orbit for eight organizations from five countries.

In addition to the communications satellites, the Shuttle carried 11 Getaway Special cannisters during the year. Fifteen middeck or secondary payloads were carried into space and back for organizations as diverse as the 3M Corp. and the IMAX film company. Two Shuttle Student Involvement Project experiments also were flown as were two deployable GAS can satellites. These very small satellites, carried aloft in a GAS can and ejected into space, initiated a new capability in the GAS program.

NASA introduced the last and lightest-weight of the Space Shuttle orbiters—Atlantis. McDonnell Douglas inaugurated their more powerful upper stage booster, the Payload Assist Module D-2.

Shuttle astronauts went outside the confines of the spaceship on three separate missions. On the first spacewalk, astronauts Jeff Hoffman and Dave Griggs attached a "fly swatter" to the robot arm in preparation for a subsequent attempt to activate the dormant Syncom IV-3 (Leasat) satellite. Nearly 5 months later, astronauts Jim van Hoften and Bill Fisher first captured and later repaired the same Syncom in a fascinating "hot wire" in orbit. This latter two-part spacewalk enabled the successful activation of Syncom in November.

The final spacewalk of the year was another two-part exercise with astronauts Sherwood Spring and Jerry Ross. These space-age "iron walkers" proved that human manipulation was alive and well as a possible candidate for Space Station assembly techniques. The separate structures, which these two easily assembled and disassembled, were among the active candidates being considered for Space Station mechanical construction. Spring and Ross not only exhibited the right stuff for orbiting construction jobs, but completed their tasks in record time and under the surveillance of 3-D cameras which will help fine tune the underwater practice runs which have become a precursor to spacewalks.

In all, six Shuttle astronauts spent a total of more than a day in space-suited activities, proving again that one of the Shuttle's most important assets is the human crew on board.

Continuing to carry out its commitment to National Security requirements, the Shuttle flew two dedicated Department of Defense missions, the second of which inaugurated service for Atlantis. In addition to the dedicated DOD missions, the Shuttle flew the first of what are expected to be a series of experiments for the Strategic Defense Initiative program.

Space Science was heavily featured in 1985 Shuttle flights with the NASA Spacelab 3 and, later in the year, Spacelab 2 missions being carried out. These missions flew the first large-scale animal colony (Spacelab 3) and tested the ESA-developed Instrument Pointing System (Spacelab 2). Both the animal colony and the IPS worked although the animal colony was found to need additional refinement before its next use. The IPS adds significantly to the repetoire of Shuttle-Spacelab on-orbit scientific capabilities and is expected to fly about once a year in the future.

The West German D-1 Spacelab mission introduced a new feature of reimbursable Shuttle flights—the scien-

tific laboratory for hire. This mission was a dedicated scientific flight purchased by the West German government's space research and development organization. Three payload specialists selected by West Germany flew as part of the mission.

In addition to the D-1 payload specialists, two of whom were West German scientists and the other a Dutch scientist, the Air Force flew a payload specialist on each of the dedicated DOD missions; McDonnell Douglas flew their payload specialist, Charles Walker, on two missions; U.S. Senator Jake Garn, one of NASA's subcommittee chairmen, flew as an observer; a scientist from EG&G Corp. and another from the Jet Propulsion Laboratory, flew as part of the Spacelab 3 mission; payload specialists from Saudi Arabia and France flew together during one of the year's busiest missions; scientists from Lockheed Palo Alto Research Laboratory and the Naval Research Laboratory flew as part of the Spacelab 2 mission; and a scientist from Mexico flew to perform experiments as part of the last crew of the year.

All told, 52 individuals flew aboard Shuttles in 1985. Of this group, 19 were scientists performing observations, experiments or investigations; 27 were U.S. military officers (16 Air Force, 5 Navy, 4 Marine Corps and 2 Army) and six were payload specialists from foreign countries (Mexico, Saudi Arabia, France, the Netherlands and two from West Germany).

Four individuals, three NASA astronauts (Bobko, Buchli and Nagel) and one payload specialist (Walker) flew twice in 1985. Although none of them flew both times with each other, Bobko and Walker and Buchli and Nagel flew once with each other.

The combined time spent in space by the 52 individuals was nearly 55 days, or over 88 orbits of the earth for a combined travel distance of nearly 22 million miles.

NASA also selected the teacher to fly in space as part of the citizen participation program. Christa McAuliffe was selected in July to fly in January 1986, and spent the rest of the year in training, along with her backup, Barbara Morgan.

On Dec. 6, NASA turned over to the National Air and Space Museum, the Space Shuttle Enterprise. The Enterprise, an aeronautical and mechanical testbed for the later orbiters, was flown to Washington Dulles International Airport on Nov. 18 from Kennedy Space Center. Eventually the Enterprise will be on view to the general public along with other large aircraft.

Space Science and Applications

Two Spacelab missions aboard the Space Shuttle and an encounter with a comet by the International Cometary Explorer (ICE) highlighted the year for NASA's Office of Space Science and Applications.

The ICE encounter with Comet Giacobinni-Zinner provided valuable information on the makeup and composition of comets. The first spacecraft to ever carry out an in situ investigation of a comet, ICE survived the close encounter and is expected to gain additional information on the make up of Comet Halley in the spring of 1986.

Spacelab 3 was a highly successful "microgravity mission" for the manned laboratory. The seven member crew carried out a highly complex series of crystal growth and fluid mechanics experiments during the seven-day mission. Other experiments included observations of aurora from space, cosmic ray studies and the testing of an animal holding facility.

Astronomy and astrophysics experiments on the Spacelab 2 mission were operated with precision during the Spacelab 2 mission in July. An Instrument Pointing System, developed by the European Space Agency, was operated for the first time and proved it can provide a stable platform for highly sensitive astronomical instruments. Thirteen investigations in 7 scientific disciplines were carried out by the seven-member crew.

The first Spartan mission was conducted when the small versatile system was deployed from the Space Shuttle to study X-ray sources in the Milky Way.

Space Station

On April 19, 1985, a little more than a year since President Reagan directed NASA to develop within a decade a permanently manned Space Station, NASA awarded competitive contracts to eight industry teams for definition and preliminary design (Phase B) of elements of a permanently manned Space Station to be operational in low-Earth orbit by the mid 1990s. The contracts will extend for 21 months and will cover Space Station elements that have been assigned to four NASA centers.

In keeping with a long term policy of international cooperation in space, and the President's invitation to U.S. friends and allies to participate in development of the Space Station, NASA signed memoranda of understanding with Canada, the European Space Agency and Japan. The agreements provide a framework for cooperation during the definition and preliminary design phase of the program. Under the memoranda, the United States and the three international partners will conduct and coordinate simultaneous Phase B studies.

The first formal discussions with the international partners were held at the end of the year to discuss and come to intitial agreement on what Space Station elements each will carry into the preliminary design phase of the Phase B effort. Agreements on elements to be provided by the international partners is anticipated by the spring of 1986 before NASA selects the baseline configuration for Space Station.

NASA also signed a memorandum of understanding with Space Industries Inc., Houston, a privately-funded venture, to exchange information during the Phase B period. SII plans to develop a pressurized laboratory that would be launched by the Shuttle and could be serviced from the Space Station.

During the first half of the 21-month long Phase B period, Space Station designers have been identifying and evaluating alternatives to the reference configuration provided in the request for proposals used by industry to bid on the Phase B contracts. With the aid of potential users from government, scientific, international, commercial and technology groups, a modified version of the "power tower" has been selected as the new reference configuration.

The new layout, the "dual keel" configuration, is rectangular and features two parallel 297-foot tall vertical keels, crossed by a single horizontal beam which supports the solar-powered energy system. In this new configuration, the pressurized modules, which can serve either as laboratories or crew habitats, are placed at the Space Station's center of gravity, the most advantageous spot on the station for experiments that require the best possible microgravity environment. The new configuration provides more space for attaching payloads, and more easily accommodates future growth of the station.

Other decisions made by Space Station designers include:

- ★ Altitude of 220 nautical miles for assembly and 250 nm minimum for operations;
- ★ Module length of 43.7 ft.; and
- ★ Closed environmental control and life support system with only nitrogen to be resupplied.

The Task Force on Scientific Uses of the Space Station conducted a second summer study and is expected to release its report in the spring of 1986. Several international workshops were conducted during 1985 and a new working group was formed to examine respective roles and responsibilities of the foreign partners in the operation of the Space Station.

Two experiments, partially funded by Space Station's advanced development program, flew on Space Shuttle missions in 1985. The first, a capillary pump loop experiment, flew in a Getaway Special canister on Shuttle mission 51-D in April, demonstrating potential thermal control techniques for Space Station components. The second, EASE/ACCESS (Experimental Assembly of Structures in Extra-vehicular Activity/ Assembly Concept for Construction of Erectable Space Structures), flown on mission 61-B in November, demonstrated how astronauts could assemble large space structures during space walks. As a result of the flight, engineers have a wealth of data to use in considering methods for future space construction.

Aeronautics

NASA's aeronautical research and technology efforts continued to expand U.S. capabilities in civil and military aviation, contributing significantly to U.S. world aviation leadership and to national security. These efforts covered the spectrum from fundamental disciplinary research to flight testing.

Joint NASA/Department of Defense programs such as the X-29 X-Wing research aircraft, the tilt rotor/JVX aircraft and the convertible engine concept demonstration substantially augmented the military data base; joint NASA/FAA programs addressed lightning strikes, wind shear, icing and other issues affecting aviation safety.

In March, NASA began the flight research program of the highly advanced X-29 aircraft at Ames-Dryden. The X-29A features a unique forward-swept wing, made of composite materials, which offers weight reduction of as much as 20 percent in comparison with conventional aft-swept wings, and forward "canard" wings whose angles relative to the airflow are computer adjusted 40 times a second to improve flight efficiency and aircraft agility.

In October, Ames-Dryden made the first test flight of a mission adaptive wing (MAW) that can change its curvature—the fore to aft curve of the airfoil—in flight for dramatic improvements in aircraft payload, range, maneuverability and fuel efficiency.

Langley's National Transonic Facility (NTF) became fully operational. The NTF is a unique world class wind tunnel using a cryogenic test gas that is capable of simulating and controlling actual flight parameters for advanced aerodynamics research.

The Cray 2 computer, currently the world's fastest and most powerful supercomputer, was installed at Ames. It represents the first major building block in the NASA Numerical Aerodynamics Simulation program, an effort to develop the world's most powerful computational facility for aeronautics research and technology.

Throughout the year tests have been conducted on single-rotation and counter-rotation propfan models in

Lewis' and Langley's wind tunnels to determine high speed performance, flutter and acoustic characteristics. Advanced propellers or propfans can provide jetliner speeds at fuel consumption rates 20-30 percent lower than jet engines.

A new and revolutionary "convertible" gas turbine engine concept was demonstrated successfully early this year at Lewis. This type of propulsion system is necessary for advanced high-speed rotorcraft concepts such as X-wing in which the rotor blades operate in a spinning mode for takeoff and landing and are stopped and locked in place as an X-shaped fixed wing for high speed flight.

A silicon nitride ceramic turbine rotor was successfully operated in automotive gas turbine test bed engine for 30 hours at temperatures up to 1900 F.

Ames' Man-Vehicle Systems Research Facility began operation. Important research into the interface between a pilot and advanced, highly-automated aircraft is being conducted.

A Composite Vertical Stabilizer was flown and certified on KC-10 aircraft.

Langley's Aircraft Landing Dynamics Facility modifications were completed in August to provide an improved capability to study such problems as runway tire traction in adverse weather conditions.

In late 1985, NASA awarded the first phase of a study contract that could lead to the design of a supersonic aircraft with a pivoting wing for increased performance at both subsonic and supersonic speeds.

In April, Dr. G. A. Keyworth II, science advisor to the President, announced three national aeronautics goals:

- ★ Subsonic Goal—Technology for an entirely new generation of fuel-efficient, affordable U.S. aircraft operating in a modernized National Airspace System.
- ★ Supersonics Goals—To develop pacing technologies for sustained supersonic cruise capability for long-distance efficiency above the speed of sound.
- ★ Transatmospheric Goals—To pursue research towards a capability for extremely fast passenger transportation between points on Earth, and also offer a vehicle that could provide routine cruise and maneuvers into and out of the atmosphere with takeoffs and landings from conventional runways.

These goals present substantial challenges for U.S. aeronautics programs which translate to exciting opportunities to NASA research and technology. NASA has used the goals to provide the framework for its aeronautics program planning for 1986 and beyond.

Space Technology

The NASA Space Research and Technology program provides critical, and sometimes unique, elements of the technology base which enables national leadership in space activities. It is focused on technology for the development of more capable, less costly space transportation systems, large space systems such as growth space station, geosynchronous communication platforms, lunar bases and manned planetary missions, and advanced scientific, Earth observation and planetary exploration.

Successful completion of development, assembly and testing of a 15-meter hoop column deployable structure and antenna system was successfully completed at Langley.

Significant changes were made to the Columbia orbiter to accommodate three research experiments to measure orbiter aerodynamic and thermodynamic characteristics as it reenters Earth's atmosphere.

The reactor thermoelectric power system concept was selected by NASA, Department of Energy and Department of Defense for further design, development and ground demonstration testing in Phase II of the SP-100 Space Reactor Power Program.

The ACCESS/EASE experiments conducted on Shuttle mission 61-B were successful. These space construction experiments are enabling the evaluation of ground-based training techniques, in space construction techniques, and productivity in space. ACCESS/EASE laid the ground work for Space Station construction.

Silicon carbide (Nicalon) fibers have been successfully woven in three-dimensional fabrics for the first time for the high temperature thermal Protection System (TPS) applications required by the Orbital Transfer Vehicle and advanced Earth-to-orbit vehicles. This innovative technology will enable lightweight, high strength, reusable TPS structural concepts.

Diagnostic sensors designed to non-intrusively measure the wear/condition of critical life-limiting rocket engine components have been successfully demonstrated in laboratory scale test rigs. These include an isotope wear detector, a fiberoptic deflectometer bearing wear detector, and a turbine temperature sensor (crack detector), based upon the use of a fiberoptic pyrometer device.

Changes in the chemistry and design of nickel-hydrogen batteries have resulted in a six fold increase in the cycle life and show promise of meeting the 50,000 cycle requirement of low-Earth orbit systems. As a result of these advances, nickel-hydrogen batteries are now a prime candidate for energy storage on the Space Station and associated scientific platforms.

A thermal model designed to calculate the temperatures of cryogenic bearing elements under variable operating conditions of speeds, loads, and coolant flowrates has been developed for the first time, and is being validated in a unique NASA bearing test facility that simulates actual loads that occur in high pressure cryogenic turbopumps.

A computational code based on a full Navier-Stokes solution of the complete aerobrake flowfield was developed and permitted a detailed study of this phenomena.

Tracking and Data

Space Tracking and Data Systems provided tracking, command, telemetry and data acquisition support for NASA missions in science, applications, space transportation and aeronautics. These tracking and data systems are transitioning from the traditional ground network station support of low Earth-orbiting spacecraft to the new mode with the successful implementation of the first Tracking and Data Relay Satellite in geosynchronous orbit.

In March, the launch of TDRS-B was deferred as a result of a problem in the timing circuit of the spacecraft. Investigations of these problems and necessary modifications to the spacecraft were completed.

TDRS-2 and 3 are currently scheduled to be launched in January and July 1986, respectively.

The consolidation of the Deep Space Network (DSN) was completed on schedule in February. The DSN provided vital tracking and telemetry support for the Soviet-French balloons which were inflated in the atmosphere of Venus in June, and supported the Giacobini-Zinner comet encounter in September. A major upgrade of the DSN was completed this year. This upgrade enabled the DSN to receive significantly more images from Voyager as it encountered the planet Uranus in January 1986.

Significant accomplishments were completed in the Data System and Communications programs. The Spacelab Data Processing Facility processed and delivered very large volumes of data received from Spacelab-3, Spacelab-2 and the German Spacelab D-1 missions during the year. Development of the Data Capture Facility for the Hubble Space Telescope (HST) was completed, and the Control Center implementation for HST continued on schedule.

A Program Support Communications Network to handle NASA's growing administrative and program management communications needs among its centers also was initiated this year.

Commercial Use of Space

The focal point for NASA's programs for encouraging commercial space activities is the Office of Commercial Programs (OCP). In 1985, the OCP funded and opened the first five of a planned series of Centers for the Commercial Development of Space. These centers are expected to become self-supporting through research collaboration by industry, academia and government agencies.

The OCP currently is overseeing the implementation of 24 agreements between NASA and industries for joint commercial space ventures; negotiating 25 other similar agreements; and seeking access for industries to U.S. government research installations that lend themselves to the development of manufacturing and materials processing in space. The OCP also is expanding NASA's traditional programs which seek to identify NASA-developed technologies that can be adapted and transferred to non-aerospace uses by the private sector.

International Affairs

NASA signed Space Station Phase B Memoranda of Understanding with Canada, Japan and the European Space Agency. These agreements cover the Detailed Definition and Preliminary Design Phase only. Under the memoranda, each side is conducting separate, parallel Phase B studies.

The memoranda established working relationships during Phase B, and provide a mechanism for agreeing on a bilateral basis on what our international partners will be developing for Space Station. Cooperation in the development, operation and utilization phases will be the subject of follow-on agreements with each partner.

NASA continued to launch communication satellites on a reimbursable basis for a number of foreign countries and international organizations. Communication satellites were successfully launched on the Space Shuttle for Australia, Canada, Mexico and the Arab Communication Satellite Organization. Payload specialists representing Arabsat and Mexico were members of the Shuttle crews manning the missions which launched the satellites.

A French payload specialist flew in June in support of cooperative life sciences experiment.

In addition to the Shuttle launches, two communication satellites were launched aboard Atlas Centaur expendable launch vehicles for the International Telecommunications Organization.

The successful 8-day flight of Spacelab 2 at mid-year completed engineering verification of the entire Spacelab system, including the Instrument Pointing System de-

veloped by ESA under the cooperative Spacelab agreement.

Reimbursable launch services aboard the Shuttle were also provided for the D-1 Spacelab mission, sponsored by West Germany's Federal Ministry for Research and Technology. This was the first reimbursable launch of the full bay Spacelab which was developed by the European Space Agency as part of the Space Transportation System. The D-1 mission included two German payload specialists and one Dutch payload specialist (representing ESA) among its crew.

Agreements were signed between Chile and the United States providing for the use of Mataveri Airport on Easter Island as a contingency landing site for the Space Shuttle in the unlikely event of an emergency during a launch from the Western Space and Missile Center.

NASA's global geodynamics program continued to expand its network of measurement sites for long-term earthquake research. Agreements were reached with Greece, Turkey and Israel to join the global network of research measurements what already includes Australia, Austria, Brazil, Canada, Chile, China, the Federal Republic of Germany, France, Italy, Japan, Mexico, Netherlands, Peru, Sweden, Switzerland and the United Kingdom. Invitations were extended to 12 countries in the Caribbean, as well as Pakistan and Saudi Arabia.

NASA's Deep Space Network participated in a unique trilateral cooperative activity in June when it tracked French instruments on balloons dropped into the Venusian atmosphere by two Soviet Vega spacecraft, yielding new and exciting data about the winds and atmospheric conditions of Venus.

Final preparations also were made for DSN participation in Pathfinder, a project to significantly improve the targeting of the European Giotto spacecraft during its Halley flyby in March 1986 by tracking the Vega 1 to obtain last minute navigation data.

A NASA primate cardiovascular experiment flew aboard the Soviet Cosmos 1667 biosatellite mission which took place July 10-17. U.S. scientists and engineers are currently participating in post-flight data analysis. NASA has participated in four previous Soviet biosatellite missions—in 1983, 1979, 1977 and 1975.

NASA continued its technical participation with France, Canada and the Soviet Union in the COSPAS/SARSAT satellite search and rescue program. Begun in 1979, the program is in its first year of operational use and has proven its effectiveness in using satellites to detect and relay emergency air and maritime transmission. To date, 510 lives have been saved through this program.

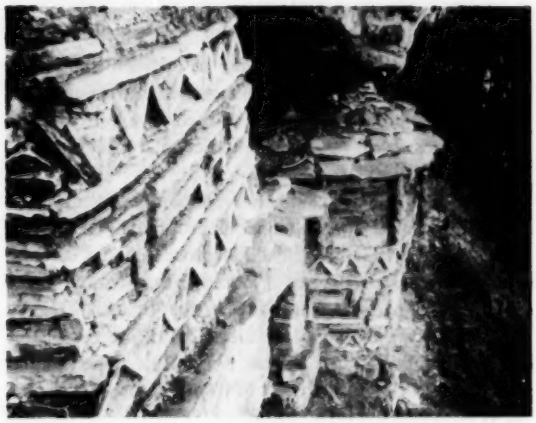
NASA and the Brazilian Space Institute, INPE, jointly conducted the largest research mission to date over the Amazon, The Global Tropospheric Experiment (GTE) Amazon Boundary Layer Experiment (ABLE). GTE/ABLE involved multiple aircraft flights over the Amazon in conjunction with ground truth observations for long-term atmospheric research.

The United States, Federal Republic of Germany and United Kingdom continued work with the Active Magnetospheric Particle Tracer Explorers (AMPTE). Data from the AMPTE mission is now being analyzed.

Possible Ancient Civilization Uncovered By NASA Technology

Using remote sensing technology, NASA's National Space Technology Laboratories (NSTL) and the University of Colorado at Boulder, uncovered information that suggests a civilization existed in the subtropical Peruvian jungles prior to the Incas.

Tom Sever, NASA's principal investigator, and Tom Lennon, archaeologist and co-director of the University's Rio Abiseo National Park Project, jointly completed a 5-day expedition into the jungles of Peru's Rio Abiseo National Park after remote sensing, by satellite and aircraft, permitted the explorers to map and prioritize the field investigation sites.



The ruins found revealed intricate masonry with red and yellow zizag designs.

Prior to the field exploration, Cerro Central, the largest site including more than 250 buildings, was discovered by the remote sensing operation. The ancient site of Gran Pajaten, which included only 30 buildings,

previously had been the major point of interest. Sever said, "We know now that Pajaten is probably the smallest and least important of the sites. We are fairly confident that we have approached the very edges of a new civilization and we believe that the farther in we go, the higher and more complicated the elevation of architecture and civilization will be."

Sever said some plant and animal species, thought to be extinct, were discovered. "That is the reason the expertise of more than 30 support people and interdisciplinary scientists was required on the expedition. Lou Whitacker, who climbed Mt. Everest in 1981, was brought in with his team to scale cliffs from which we could see the buildings, but we had no way to reach them."

This closeup of a stone carving was typical of the discoveries. Investigators in the area found that the carved stone heads of figures were set into the walls of structures.

A materials dating process is currently underway to determine when the civilization existed. Sever continued, "Our guess right now is that the civilization was pre-Inca because the architecture is circular and statutary have very delicate motifs, in comparison with the Inca ruins which are long, narrow structures with corner bases. This civilization built a totally different and perhaps more advanced architectural style than has been seen in the Inca civilization." He concluded, "The Inca expanded dramatically in a short time. Apparently, the newly-discovered ruins are from a much more complicated civilization, but they had no desire to expand. Perhaps their empire extended into the Amazon Valley. We are not sure."

NSTL was asked to collaborate in the investigation with the University's Anthropology Department because of the installation's expertise in satellite remote sensing and image analysis.

According to Sever, NSTL remote sensing specialist and archaeologist, the investigation represents the best example of remote sensing application and perhaps the only known means by which the objectives of this project could be obtained. "The job certainly could not be accomplished on foot or by ground survey. We are dependent upon remote sensing because the jungle-cloud-forest environment is treacherous and extensive. Thus, we needed to prioritize where to send the field investigators."

There are more than 1,000 square miles of park to be explored, not only for uncovering valuable archaelogical sites, but also to investigate plant and animal life inhabiting the delicate prestine environment.

Heard From Around The World

India—The India Department of Space has successfully completed third stage rocket motor static firing at SHAR Rocket Launching Station. With this achievement, India has reached another milestone for the launching of augmented satellite vehicles scheduled for March/April of this year.

Austria/Norway—Austria and Norway are to become equal in status to the other eleven members of the European Space Agency. At its 71st meeting, ESA's other member states gave unanimous approval to the granting of full membership status to the two newcomers, who had held associate memberships status since 1981. Austria and Norway have worked closely with the other European states the past 20 years, particularly on the Spacelab, Mares and ERS-1 programs.

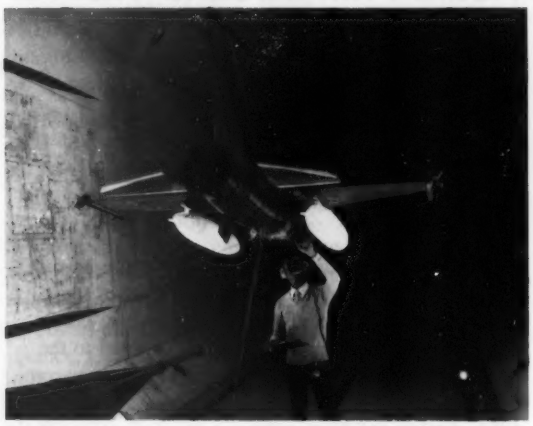
Inside NASA

In 1983, NASA's Langley Research Center completed the first major wind tunnel built in the United States in more than a dozen years. Since then, it has been rapidly improving several more of these mighty aerodynamic research facilities.

Almost $20 million is being spent over a two-year period for a variety of significant improvements to three distinctly different wind tunnels. The tunnels' test speeds range from a stiff breeze to nearly 1,000 miles per hour. They test aircraft and aircraft models from subsonic general aviation aircraft to supersonic fighters and everything in between.

Each of the wind tunnels uses giant fan blades to move air or some other gas through a closed circuit, allowing a stationary aircraft model to "fly." The interaction of the roaring wind and these precisely engineered models tell researchers what shape holds the most promise for full-scale flight efficiency, performance or safety—at a fraction of what it would cost to find any other way.

One Langley wind tunnel has been made "heavier" so it can properly test models of lighter and lighter aircraft. It is heavier in the sense that when it started up again this summer for the first time in nearly a year, 50 percent more gas could be pumped into the circuit. This extra density makes an aircraft model feel like it's flying through thicker, heavier air. This makes it easier for researchers to accurately simulate the interaction of models to the aerodynamic forces of rushing wind.



An engineer inspects the cable support system for an F-16 wind tunnel model in Langley's Transonic Dynamics Tunnel.

The giant electric motor that powers the Transonic Dynamics Tunnel has been rewound and improved so that its fan blades still move the wind at sound barrier speeds—even with this extra-dense load to push around. The gas used as a test medium in this continuous flow tunnel is Freon, already four times denser than air. Drive power has been boosted from 20,000 to 30,000 horsepower, and the tunnel cooling, control and power distribution systems have been upgraded to take the extra power.

From a practical standpoint, says Langley's Robert V. Doggett, Jr., "What this means is that now time and money can be saved in making scale aircraft models for tests in the tunnel. Before, with the trend in aircraft design toward lighter and lighter aircraft for more and more structural efficiency, our model builders had to make some models so lightweight that they were difficult to make and easily damaged. The ratio of airplane flight density to model test density is a very important factor for 'aeroelastic' tests like we conduct in the Transonic Dynamics Tunnel.

"Now, with a 'heavier' test medium, our model makers will be making slightly heavier models. This means less balsa wood and styrofoam and more metal. In addition to substantial cost savings, some aircraft models which previously could not be accurately scaled for this tunnel can now be made for the first time."

As an aircraft flies through the air, its wings and tail vibrate at certain frequencies, a harmless combination of structural response to aerodynamic pressures. Most every aircraft is susceptible—at certain speeds—to a potentially harmful interplay of those wing vibrations and aerodynamic forces called flutter. In the most severe cases, unchecked flutter can damage or destroy a wing. Wind tunnel tests can identify a potential flutter problem, and adjustments can be made to the airplane so it is perfectly safe to fly.

The Langley Transonic Dynamics Tunnel is dedicated to aeroelasticity studies and tests and has special features which make it a national resource for flutter and buffet tests.

Its increased density capability is needed chiefly to assure that new designs of high-speed aircraft and space vehicles are flutter free. Work will continue in rotorcraft and active controls research, in ground-wind loads tests of advanced space launch vehicles, and for confirmation of unsteady transonic flow theory. Because of its capabilities and special features, the tunnel usually has a two-year backlog of work. Among the first tests to take advantage of the tunnel's increased capability is flutter clearance of a Gulfstream II with an experimental advanced turboprop engine mounted on one wing. These

sub-scale tests will help clear the way for NASA-sponsored flight tests next year.

The Transonic Dynamics Tunnel modification cost approximately $8 million.

Another Langley wind tunnel is being extensively modified to increase tunnel productivity and improve flow quality. The 4- by 7-Meter Tunnel was constructed in 1970 for the study of vertical and short take-off-and-landing aircraft. "V/STOL" aircraft have unique flying characteristics; they also have unique aerodynamic problems. Helicopters, vertical take-off-and-landing jet fighters, and airplanes intended for short runways have all benefitted from the tunnel's model testing.

The 4- by 7-Meter Tunnel has a moving ground plane along the floor of the test section to better simulate flight conditions for takeoff and landing. It also has a removable side wall and ceiling in the test section, allowing a wide range of tests, and a test section size that permits use of large powered models. The tunnel's name, 4- by 7-Meter, defines the test section height and width of 13 by 23 feet. The tunnel has proven its versatility in tests of conventional aircraft as well partly as a result of these features.

The tunnel is increasingly in demand for subsonic aerodynamic research, so productivity is being increased by reducing model changeover time. Improvements to the tunnel's model preparation area will allow parallel preparation of several models, instrumentation calibration and data acquisition checkout before model installation in the test section. Modifications include fabrication of additional model support carts with improved design features, expansion of the model preparation area and new pre-test facilities: a laser velocimeter laboratory and a rotor test cell located near the tunnel test section.

Flow quality—important to accurately simulate a free stream of air—is being improved by a series of seemingly simple changes within the tunnel shell. Flaps have been added to the trailing edge of directional vanes to help the air turn a critical corner without separating into multiple flows; a new and expanded system of screens and other special-purpose filters is expected to dramatically reduce flow turbulence, as is a redesign of part of the test section.

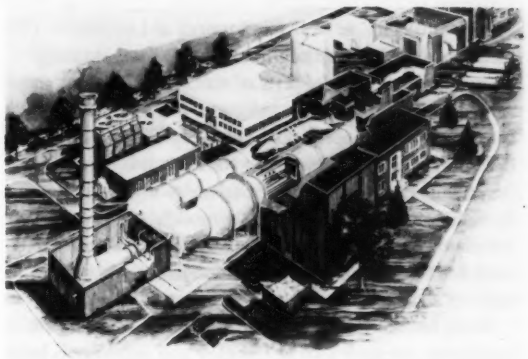
Old thermal insulation in the test section is being replaced with dual-purpose acoustic insulation to improve noise measurements of rotor and advanced turboprop systems.

When the "new" 4- by 7-Meter Tunnel resumes operation in late 1985, the first research program to benefit from its several refinements will be an aerodynamic and acoustic study of helicopter main and tail rotor interactions, followed by low-speed tests of the F-18 fighter.

The 4- by 7-Meter Tunnel work will total about $7.2 million.

The granddady of all Langley's 40-some wind tunnels, the 30- by 60-Foot Wind Tunnel, was shut down in September 1985 to complete its second major modification since its construction more than 50 years ago. Work is expected to be complete in mid-1986.

A new test section turntable and model support system head a long list of improvements designed to increase productivity, allowable model weight and accuracy of data.



This artist concept of the Transonic Facility at NASA's Langley Research Center provides a cutaway view of the wind tunnel.

When the "Full-Scale Tunnel," as it was originally named, started operation in the spring of 1931, a full-scale model or an actual aircraft was hoisted up to the cavernous test section; there, it was anchored to struts connected to a balance and scale system below the model. One of the important early discoveries: Drag tests revealed surprisingly large performance penalties from external struts and other exposed items like air scoops and antennas. During World War II, practically every high-performance aircraft used by the United States was checked out in the Full Scale Tunnel. A variety of other vehicles have undergone aerodynamic tests in the large tunnel, including dirigibles, submarines, radar antennas, gliding parachutes and even models of other wind tunnel structures.

Today, the 30- by 60-Foot Tunnel can still test full-scale general aviation airplanes and good-sized models of larger aircraft like supersonic transports; as a result of an earlier modification, it is uniquely equipped for free-flight model tests. The main research of the tunnel is now directed at the study of the low-speed aerodynamics, static and dynamic stability and control, and associated flow characteristics of military, general aviation and commuter aircraft configurations.

As part of the current modification, top speed of the tunnel will be safely restored to the 100 mph-plus range

by aerodynamic improvements ahead of its two 35-foot fan blades, which will eliminate a vibration problem. As with the 4- by 7-Meter Tunnel, model set-up time is being greatly reduced. Other modernization features will reduce tunnel operating time per research program by allowing data to be taken at shorter intervals.

No matter what type of airplane or how fast it flies, it must take off and land, and in some cases maneuver, at relatively slow speeds. This is why—even in 1986—this venerable workhorse will be reharnessed.

The 30- by 60-Foot Wind Tunnel modifications are budgeted at $4.4 million.

Incidently, the newest wind tunnel at Langley, mentioned at the very beginning, recently went fully operational with model tests of the Space Shuttle, an advanced energy-efficient transport and an electronic counter-measures version of the Navy's A-6 fighter. Called the National Transonic Facility, this super-cold "cryogenic" tunnel is giving engineers flight simulations so realistic that its tests of scale models can be correlated directly to full-scale aircraft, eliminating the need for time-consuming and less-accurate extrapolations to account for differences in size.

Wind tunnels—old and new—continue to be an invaluable research tool at Langley and promise to help maintain this country's leadership in aeronautics.

Government Quality Conference

On October 29, 1985 NASA and other interested government agencies sponsored a one-day Government Quality Conference at the Department of Labor to explore quality and productivity issues and cases of interest to senior government officials. More than 200 executives from 30 agencies and the Congress attended the unique session. The Conference addressed the quality and productivity aspects of management with an eye toward stimulating government executives into taking action within their own organizations. As David R. Braunstein, Conference Chairman and Director of NASA Productivity Programs explained in his opening remarks, "I am convinced that management approaches, not cultural aspects, make the difference. Quality is dependent upon expectations for high quality and management rewards for high quality. Productivity is dependent on the ability to build enthusiasm and to tap the talents of the federal workforce. Every study has shown that management leadership, not employee resistance, is the key to high quality and productivity."

The keynote speaker, Andrew Stofan, Director of NASA's Lewis Research Center, underscored the Conference theme with his firsthand account of putting productivity into practice. Stofan discussed his experiences at Lewis and recounted how they had been able to change the leadership's outlook and "get the workforce to feel that they were working in a creative new environment." As an example, Lewis' management was led in tackling head on "real" problems at their management retreats; problems that concerned the work climate as opposed to theoretical problems which skirted ongoing organizational issues. This was a big step toward participative management and consensus.

Another impetus toward participative management at Lewis was the establishment of quality circles. Initially planned as a year's pilot program, the initiative evolved into a network with several hundred participants. From the inception of this program, the labor unions supported quality circles and contributed to their management. At the present time, Lewis hopes to take the system a step further and make the transition to a structure which features the work unit as a quality circle. Stofan's goal for Lewis, working closely with the unions, is to ". . . have one great big quality circle of 2,700 people working together."

Stofan was followed by a panel consisting of Carole Dineen, Associate Director of Management, Office of Management and Budget; Constance Horner, Director, Office of Personnel Management; and Brian Usilaner, Associate Director for National Productivity, General Accounting Office. Each of the panel members gave their perspectives on the President's Productivity Improvement Initiatives.

Carole Dineen set the stage by observing that "the history of productivity improvement efforts in both the public and private sector was rather checkered, "and while industry is beginning to face the necessity for change, government, which accounts for 24.6% of the GNP, must be prepared to do the same. The President's initiatives are designed to "nurture a productivity culture in each agency." Agencies would be expected to build productivity into every program, and make it an integral part of everything they do to accomplish the missions.

Constance Horner viewed the role of OPM in the Productivity Program as one of reviewing the incentives plans and other personnel practices that relate to productivity to assure that programs are in place to encourage productivity as well as "to implement training programs that will help federal employees perform tasks that improve productivity." She discussed "performance management" as an important aspect of productivity and insisted that the system must be equitable. Mrs. Horner

also expressed her concern about the relationship that has developed over the past few years between the American public and the civil service. "One of my goals for my tenure as OPM Director is to try to diminish this sense of grievance on both sides and encourage some education to encourage the public to understand the valuable work the civil service does."

Brian Usilaner compared studies the GAO made a few years ago of government productivity programs with similar studies they made of top private sector firms. He observed that industry was ahead of Government. They had begun to realize that productivity had to be "a way of life." Government, too, must make productivity "a way of life" or it will become just another program. He noted that to accomplish this, an environmental change must take place by integrating productivity into basic management systems. The Presidential initiatives, with OPM and OMB support, he felt were a good beginning which could put Government on the road toward institutionalizing productivity.

Did You Know?

Thanks to space age technology, students of Indonesia's Eastern Islands University Association, spread over more than 1,600 miles of ocean, are now joined more closely by satellite communications.

A new communications system has helped make the member campuses scarce professors, research findings and library resources more widely available to the rapidly increasing number of students thoughout the region.

A teleconferencing center and an Earth station recently installed in the village of Wawotobi, on the island of Sulawesi, is powered by a solar power system managed by NASA's Lewis Research Center, Cleveland. The Earth station provides the communications link between Wawotobi and Jakarta and other Earth communications satellite system.

The U.S. Agency for International Development (AID) Rural Satellite Project became operational in Indonesia in 1984 through an agreement with the Indonesia Ministry of Education and Culture.

The teleconferencing center, a classroom large enough for 50 people, is equipped with a speaker system, microphones, a telecopier, an electronic blackboard and a computer graphics display.

The system is interactive and can connect with 11 main campus locations of the Eastern Island University Association and a conference room in the offices of the Director General of Higher Education in Jakarta.

Purpose of the teleconferencing system is to demonstrate the use of satellite communications in developing countries. The solar power system shows the feasibility and practicality of solar (photovoltaic) power systems for small earth stations in remote areas.

Diesel electric generators are generally used to power Earth stations in the absence of conventional power lines. However, the high cost of diesel fuel plus the high operation, security, and maintenance costs for diesel generators, make the use of photovoltaic systems very attractive.

The total photovoltaic array capacity to power the Earth station is 1.5 kilowatts. The battery used in conjunction with the array is expected to last about 10 years before replacement is necessary. The photovoltaic array has a life expectancy of more than 20 years.

According to Richard DeLombard, Project Manager at Lewis, "The high cost for diesel-generated electricity along with the small electrical requirement typical of remote areas make photovoltaic systems are modular, they can be tailored to meet the exact electrical requirement much more closely than can diesel generators.

The satellite system provides national communications services to the 5,000 islands inhabited by radio, telephone and telegraph services nationwide.

Prime contractor for the photovoltaic power system is Hughes Aircraft Co., Long Beach, Calif., and their subcontractor in Indonesia is P. T. Elektrindo Nusantara.

NASA and Hughes will provide operations support to provide required repair, maintenance and spare parts through June 1986. After that time, complete responsibility for the system will be turned over to PERUMTAL, the Indonesian national telecommunications authority.

Photovoltaic power systems have been used almost since the beginning of the U.S. space program to generate electricity for onboard spacecraft needs. Photovoltaic cells convert sunlight directly into electricity.

This project completes renewable energy systems programs managed by the Lewis Research Center for the Department of Energy and the U.S. Agency for International Development. Since 1976, Lewis has been responsible for the installation of 71 photovoltaic power systems in 27 countries plus the United States, including Hawaii and Alaska. These systems have provided power for entire villages, for water pumps, grain grinders, lights, vaccine refrigerators, schools, highway signs, forest lookout towers, insect traps, rural dispensaries and the Earth station.

An instrument has been develped by NASA scientists and a Stanford University engineer that may aid in treating bone fractures and bone-weaking diseases, including early diagnosis of osteoporosis which afflicts millions of the elderly.

The instrument, which measures bone mass and stiffness, was developed to help scientists combat the bone loss that may occur during long-term space flight. It will be useful for manned space stations and extended space journeys, such as trips to Mars.

Known as the Bone Stiffness Analyzer, the instrument is based on the idea that the bone behaves as a structural beam. Well developed concepts for testing the stiffness and displacement properties of structural beams can be applied to measuring the same properties of leg and arm bones.

The theory initially was demonstrated by Dr. Donald Young, a physiologist at NASA's Ames Research Center, Mountain View, Calif. Dr. Charles Steele, professor of mechanical engineering at Stanford University, adapted the instrument for clinical application.

After further tests, Young and Steele plan to use the instrument to create an exercise program for maintaining bone strength during the weightless environment associated with extended spaceflight missions when bones tend to atrophy.

NASA selected official names for two planetary missions scheduled for flight in 1988 and 1990. A mission to map the planet Venus, previously known as Venus Radar Mapper, is now called Magellan. The Mars Geoscience/Climatology Orbiter is now named Mars Observer.

The Magellan mission will map the entire surface of planet Venus for the first time, using a synthetic-aperture radar instrument. The radar—which can image the surface despite the cloud cover that enshrouds Venus—will map the surface with subkilometer resolution adequate enough to identify geological processes and provide information that will lead to an improved understanding of the planet's evolution. The spacecraft will orbit the planet about once every 3 hours, coming as close as 250 kilometers from the surface.

The Magellan spacecraft, attached to a Centaur-G upper stage, is scheduled for launch from the Space Shuttle in April 1988 and arrival at Venus in July 1989.

The name selection resulted from a search conducted by the NASA Headquarters Office of Space Science and Applications, aided by the The Planetary Society.

The Mars Observer mission will map the planet Mars to determine the global elemental and mineralogical character of its surface and to investigate the Martian climate, both present and past.

The Observer spacecraft will be adapted from an existing, production-line type of Earth-orbital spacecraft to reduce costs. This mission will be the first in a series of low-cost planetary observer missions using this approach.

Use of the generic Observer name for a series of related space missions is in keeping with the practice established by NASA's Mariner, Pioneer and Explorer series of missions.

Mars Observer is scheduled for launch in August 1990 from the Space Shuttle. It is scheduled to arrive at Mars in August 1991.

The Magellan and Mars Observer projects are managed by the Jet Propulsion Laboratory, Pasadena, Calif., for NASA's Office of Space Science and Applications.

Contractor News

Boeing Aerospace Operations (BAO) of Cocoa Beach, Fla., was selected for award of the Flight Equipment Processing Contract (FEPC) at the Johnson Space Center, Houston. BAO has the Wornick Co. of McAllen, Texas, as a subcontractor.

The 3-year award, with a 2-year priced option, will be for services beginning in January 1986 at an estimated total cost of approximately $76.5 million. The contract also includes provisions for two additional, unpriced 5-year extensions.

JSC will manage the work under a cost-plus incentive/award-fee contract arrangement which includes an incentive fee for sound cost management and an award fee based on performance.

BAO will assume responsibility for receipt, launch preparation and post-launch activities relating to the overall processing of crew-related flight and flight-type equipment required to support the Space Transportation System program. The primary function of the flight equipment is to support the flight crew in its daily operation of the orbiter vehicle. The contractor will process and resupply the individual equipment items in preparation for launch and operate and maintain support equipment required for the successful processing of the equipment. Included are: Extravehicular Mobility Unit (space suit), food and medical systems, communications equipment and other miscellaneous items.

Hamilton Standard Division of United Technologies Corp., Windsor Locks, Conn.; ILC, Dover, Del.; and RCA Service Co., Cherry Hill, N.J., will remain as suppliers for spacesuit equipment and communications equipment.

This selection represents the consolidation, into one contract, of work being performed by 16 firms under 19 contracts.

In addition to BAO, final negotiations were conducted with Hamilton Standard Management Services, Inc. of Houston.

NASA's Lewis Research Center selected **Cortez III,** of Albuquerque, New Mexico for final negotiations leading to award of a cost-plus-award-fee, 5-year contract valued at approximately $45 million for consolidated logistic and administrative support services.

All work will be performed on-site except for an instrument repair facility the contractor will be required to provide locally.

The contract integrates various on-going service contracts and planned new starts into a single, center-wide support service effort. Types of functions the contractor is expected to perform include security, general delivery, vehicle maintenance, administrative, clerical, instrument support, supply services, and related service efforts.

The selection represents a joint effort by NASA Lewis and the Small Business Administration (SBA) to place contracts into SBA's Minority 8(A) Program through formal technical competition. Qualified senior 8(A) firms submitted technical proposals to consolidate the current contracts into a single support effort. Proposals were then evaluated under formal NASA evaluation guidelines.

Fiscal Year 1985
Major Space Act Awards
$1,000 or Greater

Title of Contribution	Contributor(s)	Employer(s)
Cooling Garments	Patricia J. Kirk	ARC
	Dr. Bill A. Williams	Former ARC
	William E. Elkins	Former ARC
Oxygen Post-Treatment of Plastic Surfaces	Theodore J. Wydeven, Jr.	ARC
Gait Analysis Telemetry System	Salvador A. Rositano	ARC
	Richard M. Westbrook	
	Edward P. Luzzi	
Fire Blocking System for Aircraft Seat Cushions	John A. Parker	Former ARC
	Demetrius A. Kourtides	ARC
Advanced Flexible Reusable Surface Insulation	Howard K. Larson	ARC
	Francis J. Pitoniak	
	Daniel B. Leiser	
	Carlos A. Estrella	
	Marnell Smith	
	Howard E. Goldstein	
	Paul M. Sawko	
Portable Synthesized Speech System	Gilbert H. Leibfritz	ARC
	Howard Larson	
Alkali-Metal Silicate Binders and Methods of Manufacturing and Potassium Silicate Coatings	John B. Schutt	GSFC
Method of and System for Classifying Emergency Locating Transmitters and Emergency Position Indicating Radio Beacons	Paul E. Wren	GSFC
Multiprism Collimator	Peter O. Minott	GSFC
Stirling Cycle Cryogenic Cooler	Max G. Gasser	GSFC
	Allan Sherman	
	Philip A. Studer	
	Alexander Daniels	North American Philips Corporation
	Michael P. Goldowsky	
High Voltage Isolation Transformer	Arthur Ruitberg	GSFC
	Carroll H. Clatterbuck	
High Voltage Power Supply	Arthur Ruitberg	GSFC
	Kenneth M. Young	

Another Dividend from Air and Space

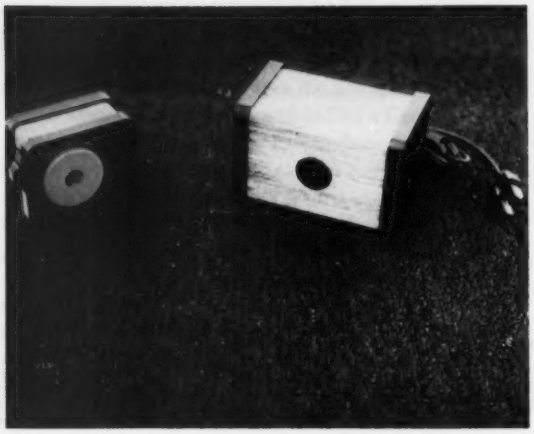
Research and development in aeronautics and space have provided numerous benefits for all Americans — and at a tiny percentage of the tax dollar. Here is an example:

Visual Alert System

At right, inventor James Campman of Grace Industries, Inc., Transfer, Pennsylvania, is displaying a door installation of the company's Concept I Visual Alerting System (VAS), a multipurpose security device for home or office that combines visual and audible alerts. Intended primarily as a burglar alarm, smoke alarm, door or telephone alert for hearing-impaired people, the VAS is a second-generation spinoff based on electronic circuitry originally developed under contract to Langley Research Center.

The VAS consists of two basic components shown in the lower photo: an audio transponder (white unit) and a companion receiver. Attached to a door, window or telephone, the transponder detects vibrations caused by such noise, as a knock on a door, a break-in attempt, opening of a window or a ringing telephone. The vibrations are converted into a loud beeping tone that is transmitted to the receiver plugged into an electrical outlet. The receiver, in turn, switches on a lamp or causes it to flash. The receiver's sensitive electronic circuitry also detects sounds made by smoke alarms and provides a visual alert. The VAS is designed to deter intruders by the loud beeping noise and additionally to serve as an economical reliable visual signaling device for those unable to hear sonic alerts.

The VAS traces its technological lineage to low noise, low voltage circuitry developed by Applied Cybernetics Systems Inc. For NASA/Langley as part of a telemetry system for relaying spacecraft data to ground station computers.



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